PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Re-inforced Flexible Plastic Hose Pipes and method of making same

We, TITEFLEX INC., a Corporation organised and existing under the Laws of the Commonwealth of Massachusetts, United States of America, of Hendee Street, Springfield, Massachusetts, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to plastic hose pipes and to methods of making such hose. More specifically, it relates to hose made with a plastic manufactured by E. I. DuPont de Nemours of Wilmington, Delaware under the Registered Trade Mark "Teflon" and consisting of polytetrafluoroethylene.

One object of the invention is to provide an improved flexible plastic hose reinforced with fibre-glass, the interior of the hose being plastic so that the hose has the chemical properties of the plastic. Another object is to provide a braid-covered plastic hose with an intermediate layer of fibre-glass to protect the plastic from chafing by the braid.

Another object is to provide a method of making corrugated plastic hose by using an inner layer of malleable material which serves as a collapsible mandrel or shield for retaining the plastic in place during curing, fusing, or sintering of the plastic. Whether the plastic is cured, fused or sintered depends, of course, upon what plastic is used, but the expression "heat treating" is used herein as a generic expression to designate any of these treatments of the plastic.

The preferred embodiment of the invention is a polytetrafluoroethylene hose made by wrapping flat strip material in a helix and with an inner layer of metal foil, such as aluminium foil, which prevents inward flow of the polytetrafluoroethylene when it is subsequently heated to sinter it. The metal foil is then removed from within the hose by a rolling operation that makes practical the removal of the foil from tubes of any length.

Another advantage of the inner layer of metal foil, in combination with polytetrafluoroethylene, is that it facilitates the heating of the polytetrafluoroethylene by induction heating. Polytetrafluoroethylene must be heated above 620° F. for sintering, and it is difficult to heat by induction heating. The metal layer is readily heated and transmits its heat directly to the adjacent polytetrafluoroethylene.

Still another object is to provide a plastic hose with fibre-glass reinforcing fibres and with the side walls of the hose corrugated so that the plastic at successive locations along the length of the hose is held in position by the unstretchable glass fibres in conjunction with the metal foil layer. This provides a more secure and reliable bond between the different layers of strip material from which the hose is wound.

Other features of the invention will be pointed out in the following description of a preferred form with reference to the accompanying drawings, in which:—

Fig. 1 is a diagrammatic, isometric view showing the hose of this invention and illustrating the method by which it is made;

Fig. 2 is an enlarged sectional view through a portion of the wall of the hose during the different steps in its manufacture;

Fig. 3 is a greatly enlarged sectional view through the hose wall showing the different layers;

Fig. 4 is a diagrammatic view illustrating the way in which the hose is rolled to release the inner layer of metal foil; and

Figs. 5 and 6 are sectional views taken on the lines 5—5 and 6—6, respectively, of Figure 4.

Fig. 1 shows a mandrel 11 about which strips of material are wrapped to form the

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hose of this invention. In the preferred construction, a strip of aluminium foil 12 is initially wrapped on the mandrel 11 from a reel 13 with the edge portion of each convolution overlapping a portion of the next convolution. Although aluminium foil is preferred, other metal foil can be used, such as copper or other malleable foil. The mandrel 11 may be rotated, but the strip 12 can be wrapped by moving the reel 13 with an orbital movement around a stationary mandrel. The mandrel can be lubricated in the conventional way to facilitate stripping of the helically wound foil strip 12 from the mandrel, but conventional lubricants char and discolour the inside of the hose in subsequent heat treatment. In the preferred embodiment of the invention a light film of plastic, such as Teflon, is coated on the side of the foil strip that contacts with the mandrel 11, and this plastic serves as a solid lubricant. The lubrication of the foil facilitates stripping from the mandrel by maintaining the coating of plastic between the mandrel and the foil of the subject matter of our copending Application No. 32496/60.

A strip of Teflon tape 15 is wrapped over the inner layer formed by the strip 12, preferably on a helix with successive convolutions overlapping. The Teflon tape 15 is supplied from a reel 16. More than one Teflon tape 15 can be wrapped on the mandrel depending upon the desired wall thickness for the hose; and it will be understood that the tape 15 is representative of a layer of plastic material wrapped over the inner foil layer and consisting of one or more superimposed strips of tape.

In the preferred construction, outside of the layer of plastic tape 15, a composite strip 18 is wrapped around the mandrel, the strip 18 being supplied from a reel 19. This strip 18 consists of reinforcing fibres preferably coated with plastic material which in the illustrated construction is the same plastic as the inner layer. In the preferred construction, the strip 18 consists of a woven fibre-glass fabric 21 (Figures 2 and 3) impregnated with Teflon 23, and is wound in the helix with successive convolutions overlapping. The Teflon 23 fills the interstices of the woven fabric 21, covers the glass fibres of the fabric 21, so that the glass fibres are completely covered by the Teflon, and improves the bond of the glass to the Teflon liner.

The strips 12, 15 and 18 are maintained under tension so that they wrap tightly and the hose is passed between corrugating apparatus consisting of a grooving worm 25 and a grooving nut, 26. The worm 25 is located within the hose and is supported internally through mandrel 11; and the nut 26 surrounds the outside of the hose and is supported from any suitable outside source. The worm 25 and nut 26 are rotated in the same direction and they are located at a fixed station along the length of the mandrel so that the rotation of the threads of the worm 25 and nut 26 feeds the hose forwardly.

Beyond the worm 25 and the nut 26, the hose, designated by the reference character 28, passes between a snubber or inner compressing element 31 and an outer threaded forming element 32. The inner compressing element provides a brake for retarding the axial movement of the hose as well as retarding rotation of the hose. The thread on the outer forming element 32 has a lesser pitch than the threads on the worm 25 and nut 26 and they are rotated at the same speed as the worm and nut so that, with the movement of the tube retarded by the compressing element 31, the sides of the hose corrugations are crowded close together and shaped by the outer forming element 32, as clearly shown in Figure 2. The braking of the axial movement may be performed by an outside element, if desired.

The inner compressing element 31 is supported from a bar 33 which extends through the hollow interior of the mandrel 11, and the outer compressing element 32 is supported from any suitable outside source. As in the case of the worm 25 and nut 26, the compressing elements 31 and 32 are maintained at a fixed station axially of the hose. The inner compressing element 31 does not rotate, and its supporting bar 33 is connected to a fixed frame beyond the end of the mandrel 11, when using a rotating mandrel. This apparatus for corrugating the hose 28 and for pressing the corrugations closer together is of a known type.

After being corrugated in the manner already described the hose is given a heat treatment to bring the plastic to the desired final condition. In the case of Teflon, the hose is subjected to a sintering temperature above 620° F., this sintering being necessary to give Teflon the strength and other desired physical and chemical characteristics and the operation is used in substantially all Teflon hose manufacture and is well understood in the art. In the drawing, the sintering operation is illustrated diagrammatically by passage of the hose between induction coils 35 and 36.

The tube formed by the inner layer of metal foil has a high di-electric loss; and when induction heating is used, the Teflon is heated largely by conduction of heat to the Teflon from the metal foil. The heat for sintering the Teflon can be generated by electrical resistance, the metal foil being used as a conductor and a heavy current being passed through the foil from brushes or other electrical connections. The more conventional heating by passage through a furnace can be used. It will be understood therefore, that in the broader aspects of the

invention, the induction heating shown in the drawing is merely representative of means for heating and sintering the Teflon.

The final step in the manufacture of the hose of this invention is the application of a metal braid 40 to the outside of the hose. This step is illustrated diagrammatically in Figure 1 by the application of different strands 42 to the outside of the hose. The braiding of plastic hose for greater strength is well understood in the art and no further illustration of the braiding is necessary for a complete understanding of this invention.

Since the hose is made of Teflon, or other plastic, in order to obtain the chemical properties of the plastic it is necessary to remove the inner layer of metal foil 12 from the hose. This can be done either before or after the braiding operation but must be done after the heat treating because the principal purpose of the metal foil is to prevent excessive contraction of the Teflon layer as it cools after the heat treatment.

Figures 4—6 illustrate the way in which the inner layer of foil 12 is removed. The hose 28 is passed between rollers 46 which compress the hose laterally. The plastic layers of the hose recover their original shape after passing beyond the rollers 46 but the malleable inner layer of foil 12 is crushed by the flattening of the hose between the rollers 46 and remains crushed, as shown in Figure 5. Because of the flexing of the hose wall as it passes into and out of the bite of the rollers 46, the space between the corrugations spread and this facilitates the removal of the inner layer from the corrugations. The hose is then passed between further rollers 48 which compress it laterally at right angles to the previous compression. The foil 12 is then crushed as shown in Figure 6 and can be readily removed.

WHAT WE CLAIM IS:—

1. The method of making flexible, reinforced plastic hose pipes which comprises wrapping a helix of the plastic and reinforcing material for the plastic around a malleable and collapsible tube that provides a temporary inner layer of the hose, corrugating the inner layer and the plastic and reinforcement simultaneously whilst holding them together during the corrugating step, heat treating the plastic while preventing collapse of the hose by means of the support, afforded by the inner layer, and, after heat treating, crushing the inner layer and withdrawing it from the hose.

2. The method of making flexible glass reinforced plastic hose pipes which comprises wrapping a helix of the plastic and fibre-glass forming a reinforcement thereof around a malleable and collapsible tube that provides a temporary inner layer of the hose, corrugating the inner layer and the plastic and fibre-glass simultaneously by the application of force to both the inside and outside of the hose said force holding the inner layer, plastic and fibre-glass together during the corrugating step, then heat treating the plastic while preventing collapse of the hose by means of the support afforded by the inner layer, and after heat treating, removing the inner layer by temporarily flattening the hose first in one direction and then in another to crush the malleable and collapsible tube that provides said inner layer, and withdrawing the crushed tube axially from the hose.

3. The method of making flexible, reinforced plastic hose as claimed in either of the preceding claims in which the collapsible tube is formed by wrapping a strip of material in a helix around a mandrel and ahead of the helix of plastic and reinforcement, but as a part of the same operation as the wrapping of the plastic and reinforcement, and in which the hose is progressively stripped from the mandrel, and the hose is corrugated at a region adjacent to the end of the mandrel and progressively in co-operation with the stripping step.

4. The method of making flexible, reinforced plastic hose as claimed in any of the preceding claims in which the plastic is wrapped in at least two layers, one of which layers is a plastic strip without reinforcing and the other of which layers is a woven fibre-glass strip impregnated and coated with plastic and in which the different layers of plastic are bonded together when heated during the heat-treating step.

5. The method of making flexible reinforced plastic hose as claimed in any of the preceding claims in which the plastic is wrapped around a tube which has a high di-electric loss, and the plastic is heated by the application of induction heating, the plastic being heated largely by conduction of heat to the plastic from the material having the high di-electric loss.

6. The method of making flexible reinforced plastic hose according to any of the preceding claims and in which the collapsible tube is formed by wrapping a strip of malleable metal foil around the mandrel with the edge portion of each convolution of the metal foil overlapping a portion of the next convolution.

7. The method of making reinforced, flexible plastic hose pipes comprising wrapping a strip of stiff but malleable material in a helix to form an inner layer, helically wrapping on said inner layer strips of material of which the hose is to be formed including at least one layer of plastic strip and at least one layer of reinforcing material for the plastic, progressively corrugating all of the layers together as they pass beyond the region of wrapping and in directions to produce generally circumferential corrugations,

heat treating the plastic material and preventing inward displacement of the heated plastic by supporting it with the inner layer, and after the heat treating of the plastic detaching the inner layer of strip material from the plastic layer by temporary flattening of the hose in different radial directions to crush the malleable inner layer of material and leave it free of the plastic as the plastic springs back to its original shape, and then removing the crushed inner layer by pulling it out of the hose in an axial direction.

8. The method of making reinforced, flexible plastic hose according to Claim 7 in which the reinforcing material is covered with plastic material, and a woven metal braid is applied to the outside of the hose in contact with the plastic that covers the reinforced material.

9. The method of making reinforced, flexible plastic hose according to either of Claims 7 or 8 in which the inner layer is wrapped on a mandrel and the hose is progressively stripped from the mandrel prior to the corrugating step.

10. The method of making reinforced, flexible plastic hose according to any of Claims 7, 8 or 9 in which the hose is corrugated by the application of distorting forces applied progressively along a helical course to produce a helical corrugation, and the inner layer and the other layers are held together during the corrugating by applying the same distorting forces simultaneously to the inner layer and the other layers.

11. The method of making reinforced, flexible plastic hose according to Claim 10 and in which the compressing of the hose in different radial directions is performed by the application of hose-distorting forces from the outside of the hose with the layers of the hose unsupported from the inside whereby the corrugations of the inner layer can pull loose from the corrugations of the overlying plastic layers.

12. The method of making reinforced, flexible plastic hose according to any of Claims 7 to 11 in which the flattening of the hose is performed by progressively applying rolling pressure to the outside of the hose at axially spaced locations as the hose moves past rolling stations.

13. The method of making reinforced, flexible plastic hose as described in Claim 12 in which the wrapping is continued to produce a long hose, and the crushed inner layer is left in the hose until the entire length of the hose is finished and the entire length of the inner layer is crushed and then removing the entire length of the inner layer at the same time.

14. The method of making flexible hose pipes from flat strips of malleable metal foil, plastic, and plastic-coated fibre-glass, which method comprises wrapping the strip of metal foil in a helix with edge portions of the successive convolutions overlapping one another to form a first layer, wrapping the strip of plastic over the metal foil and in a helix with successive convolutions overlapping to form a second layer, wrapping the strip of plastic-coated fibre-glass over the plastic strip and in a helix with successive convolutions overlapping to form a third layer, corrugating all layers of the hose simultaneously with corrugations extending substantially circumferentially around the hose to interlock the layers and to increase the flexibility of the hose, heat treating the plastic to a temperature that bonds the second and third layers together, and preventing inward flow of the heated plastic by means of the metal foil layer, and thereafter removing the metal foil from within the hose.

15. The method of making flexible plastic hose according to any of the preceding claims in which the plastic is polytetrafluoroethylene.

16. An interim product of manufacture comprising a hose pipe having a wall made of plastic with fibre-glass reinforcing imbedded therein and an inner layer of the wall consisting of other material, the reinforced plastic being resilient whereby it springs back when the hose is flattened and the flattening force is removed, and the other material being malleable whereby the inner layer remains in a crushed condition after the hose has been flattened, the wall of the hose including the inner layer being corrugated with generally circumferential corrugations which interlock the inner layer and the plastic and fibre-glass in a composite wall structure.

17. An article of manufacture comprising a reinforced plastic hose pipe having a wall with an inner surface of plastic, a layer of woven fibre-glass imbedded in the wall and impregnated with plastic, the outside of the woven fibre-glass being coated with plastic and the wall of the hose being corrugated with generally circumferential corrugations, and a woven metal braid covering the outside of the corrugated wall and with the braid chafing on the fibre-glass minimized by the plastic coating over the outside of the fibre-glass.

18. An article of manufacture as claimed in either of Claims 16 or 17 in which the plastic is polytetrafluoroethylene.

19. In the manufacture of plastic hose pipes having corrugations extending around it, and which hose comprises helically wound layers of stretchable plastic and unstretchable foil, with said foil forming the inner layer and interlocked with the plastic by extending into the corrugations, the improvement which compri- subjecting the hose to pressure sufficient to expand the plastic and thereby pull it loose at the corrugations from the foil, and there-

after removing the foil by pulling it longitudinally from the hose.

20. The method of making reinforced, flexible plastic hose pipe substantially as described with reference to the accompanying drawings.

21. Reinforced flexible plastic hose pipe substantially as described with reference to the accompanying drawings.

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